GLOSSARY OF TERMS AND ABBREVIATIONS

BCF	- See Halon 1211.
CPU	- Central Processing Unit.
Dedicated Sub-Circuit	- An electricity supply taken direct from a main distribution point and hence likely to be relatively free of disturbances caused by the operation of other local items of electrical equipment.
Dew Point	- The temperature at which the air becomes saturated with water vapour (ie 100% Relative Humidity).
Disk Unit	- The device which reads information from, or writes information to a magnetic disk (also known as a hard disk). Such disks may be fixed or removeable (exchangeable).
Diskette Unit	- As disk unit but the disks (diskettes) used are smaller and flexible with a storage capacity considerably less than a hard disk.
DX System	- Direct Expansion System: a system which cools air by passing it through a heat exchanger within which a refridgerant flows.
Electronic Data Processing Installation	same as 'Computer Installation'.
EMI	- Electromagnetic Interference.
F	- See farrad.

farrad (F)	-	The unit of electrical capacitance.
Flexible Disk/Floppy Disk	-	Same as diskette (See Diskette Unit)
GHz	-	Gigahertz (one thousand million (10^9) Hertz)
Glare Index	-	A calculated number (based on room finishes, luminaires, diffusers etc) which gives a measure of the amount of glare present in a room. The lower the number the less glare.
Hz	-	See hertz
Halon 1211	-	A hologenated Fire Extinguishant gas; Bromochlorodifluoromethane (BCF).
Harmonic Distoriton	-	This is a measure (in % terms) of the deviation of the electricity supply waveform (voltage) from a true sinewave.
hertz (Hz)	-	unit of Frequency (see also kHz)
kg	-	Kilogramme (one thousand grammes) - unit of mass
kHz	-	kilohertz (thousands of cycles per second)
kN	-	Kilonewton (one thousand newtons)
kVA	-	Kilovolt amperes (Volts x amps x 1000)
kW	-	Kilowatt (one thousand watts)

Latent Heat (of air)	- Heat absorbed or released when the moisture vapour in the air changes its state (eg vapour to water) during which there is no temperature change.
Limiting Glare Index	- See Glare Index.
Lux (lx)	- Unit of illumination.
MN	- Meganewton (one million Newtons).
Modem	- A contraction of the term modulator – demodulator. A device used to convert serial digital data from a transmitting terminal to a signal suitable for transmission over a telephone line and to reconvert the signal to serial digital data for acceptance by a receiving terminal.
NC	- Noise Criterion (number) - See NR.
NR	- Noise Rating: a number based on a series of empirical curves derived from the equal loudness contours that the human ear experiences. Very similar to NC.
Newton (N)	- Unit of Force.
Oersted	- Unit of Magnetic Field Strength.
ohm (Ω)	- Unit of Electrical Resistance.
pF	- Picofarrad (one million millionth (10^{-12}) of a Farrad).

plenum	- A space used for forced air ventilation.
RFI	- Radio Frequency Interference.
RH	- Relative Humidity: a measure in percentage terms, of the moisture content of the air. It is a function not only of the absolute moisture content of the air, but also of the air temperature.
TN-S	- A system of electricity supply and earthing as described in The Institution of Electrical Engineers "Regulations for Electrical Installations".
Transient	- A brief and usually significant variation (say up to 1ms duration) of the electricity supply voltage.
U-Factor	- Heat Transfer Coefficient: the amount of heat transferred through a unit area of a given structure for every degree difference across the structure (eg $W/m^{2}\,{}^{\circ}C$).
Uninterruptible Power Supply (UPS)	- Electrical equipment, placed in the electricity supply line, which "buffers" the load (eg a computer) and maintains supply during short breaks (say up to 10 mins).
VDU	- Visual Display Unit: a unit which comprises a Cathode Ray Tube display.

VDS	-	Visual Display System; a small computer based system comprising of a number of units eg VDU, keyboard, printer, diskette, small processor etc.
W	-	watt; the unit of power, generally, electrical power..

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DEVICES TO IMPROVE MAINS SUPPLY QUALITY

(a) **Motor alternators/Static Inverters**

Where the main supply voltage is subject to severe switching transients, for example from lifts or workshops within the building or industrial plant in the neighbourhood connected to the same feeder, computer equipment must be electrically isolated from them. This can be done by using a buffer motor alternator set, or static inverter. Motor alternator sets/static inverters must be provided for any computer equipment which requires supply at a frequency other than 50Hz (eg those American machines which operate at 60Hz and for machines using a 400Hz supply). To ensure continuity of the supply during maintenance or periodic overhaul, a standby set/inverter, or a 50Hz a mains direct facility, should be provided.

(b) **Constant Voltage Transformers (CVTs)**

These devices are designed to provide a constant output voltage from a widely varying input voltage. They are ideal for use in areas where the mains is subject to slow variations but they are not usually very fast reacting and are therefore not a satisfactory solution for high speed transients.

(c) **High Isolation Transformers (HITs)**

These transformers are designed to provide a high degree of isolation between primary and secondary windings. HITs are effective against most types of noise on a power line and they will severely attenuate transients. They are ideal for isolating noise-producing equipment from other equipment sharing the same power line.

(d) **Power Line Filters**

These are high frequency filters and are designed to attenuate high frequency transients on a power line but their location can be critical and they should be fitted as near to the computer equipment as possible. Because the filter sizes and costs are inversely proportional to frequency, Power Line Filters are not normally practical for attenuating frequencies below 10 kHz.

Filters may also be used to remove electromagnetic interference (EMI) from a power line. This may exist as Common Mode EMI (which occurs when noise is present between line (live) and earth and/or between neutral and earth) or Differential Mode EMI (which consists of noise between line (live) and neutral, although one of these lines may contain no EMI). In the first case, filters should be connected between line and earth and between neutral and earth. In the second, filters should be connected between the line and neutral lines.

At installations utilising residual current protection devices, unwanted disconnection of the computer equipment may occur because the RFI filters used within the computer equipment pass earth leakage currents and can cause the device to "trip", switching off the mains supply.

(e) **Voltage Dependent Resistors (VDRs)**

VDRs, when connected across mains power supply lines, will limit the level of high voltage transients, the level being determined by the rating of the device selected. When exposed to high voltage transients the VDR's impedence changes by many orders of magnitude, from an extremely high value (approaching that of an insulator) to a much lower one (that of an electrical conductor) thus 'clamping' the transient to a safe level. Since the potentially destructive energy of the transient is absorbed by the VDR it is important when selecting the device that the energy rating is adequate.

TESTING AIR-CONDITIONING SYSTEMS

Normal tests

1.1 Thermostatic controls: thermostatic controls must be tested to prove their ability to maintain the desired conditions under normal operation. Mechanical operation of all dampers should be checked.

1.2 Safety controls: refrigerant pressure cut-outs, compressor oil-pressure protection and, where fitted, chilled-water low-temperature cut-outs, no-flow devices and over limit controls, should be checked.

1.3 Sequence controls: the proper sequencing of all refrigeration compressors and ancillary plant, such as condenser-water pumps, cooling-tower fan or evaporative-condenser fan and pump, should be checked.

1.4 Step controls: step control or capacity control, of compressors, should be checked; the checks should include an unloaded start of the compressors.

1.5 Alternative controls: alternative, manual or automatic, working arrangements for the compressors should be checked. Where any pump or fan is duplicated and arrangements have been made for automatic change-over this operation should be checked.

1.6 Flow rates: the recirculated and fresh-air flow rates should be measured. Measurements should be taken at points relatively free from turbulence, within the air circuit, otherwise it will be difficult to obtain accurate values. Chilled water flow rates should also be measured where appropriate.

Particular tests

2.1 In addition to the normal tests, certain special tests may be necessary depending on particular requirements of the plant.

(a) Air-filtration. A test of the air-filtration system should be carried out where experience in use indicates that a dust problem exists within an installation which includes a high standard of filtration (that is, better than an arrestance of 80% to Eurovent 4/5). A test of the whole installation rather than a laboratory test which tests only the filters, is preferable. The most practicable site test method is to use a direct reading dust counter which can record the number of dust particles within a specified size range in a unit volume of air. This method of defining air-borne dust levels is used by many computer suppliers when specifying maximum acceptable dust levels. Dust counts should be taken at a number of locations in the computer suite (e.g air supplied to the room, within the room, and air exhausted from the room) and under working conditions.

(h) Noise. If a noise level, from the plant alone, has been specified in the computer area, noise level measurements will be necessary. The levels are normally specified in terms of NC or NR curves, the design aim being 50 or less in the computer room and 45 or less in associated office areas. Similar external tests might be necessary where much reduced levels are required (i.e in residential areas).

Acceptance tests

3.1 When the normal and particular tests have been completed, a final, formal, acceptance test should be arranged (as part of the contract) to demonstrate to the client or his representative, that the air-conditioning installation functions satisfactorily, so that the computer may be installed. All acceptance tests are to be carried out by the contractor under the instructions of the project engineer or commissioned consultant.

Simulated maximum summer and winter design conditions

SUMMER DUTY

4.1 Local electric heating by means of fan-assisted convector heaters should be installed temporarily to simulate:

(a) the heat dissipation from the computer and all ancillary equipment;

(b) the extra heat gain through the structural fabric from any differences between the design external air temperatures and the external air temperatures on the day of the test;

(c) the extra heat gain from the fresh air due to any difference between the design external air temperatures and the external air temperatures on the day of the test;

(d) the maximum solar heat gain in excess of that experienced on the day of the test;

(e) the extra heat gain from the number of persons normally expected to be present over the number present on the day of the test.

4.2 Heat sources should be placed as nearly as possible in the positions of the sources they represent, those representing the computer should be fan heaters directed vertically. No simulation of room latent heat gains is necessary since variations will be small. Kettles, etc should be used to simulate the difference between the latent heat of the fresh-air in summer design conditions and the actual conditions on the day of the test and positioned such that the steam enters the same part of the air-circuit as the fresh-air. The return air duct or plenum is often the most suitable position.

4.3 Estimates of extra solar heat gain will be approximate. A proportion of the maximum solar-heat gain used for design purposes should be simulated on the test day, depending on actual weather conditions. The actual heat gain could be large.

4.4 Simulation of the total heat load (particularly in the winter) may prove difficult because of electrical supply limitation. Any excess heat which cannot be simulated should be calculated and the test should show spare capacity of the cooling plant, at least equal to the result of that calculation (although some items of plant will not have been fully loaded).

WINTER DUTY

4.5 The plant should be made to show its capability to raise the room to, and hold it at, the desired temperature in cold weather when computer equipment is not operating.

4.6 Where the structure of the computer suite is exposed to winter conditions or where a high temperature reheat source is used, the plant should be able to show the designed temperature rise above the prevailing outside ambient temperature. Where a low temperature reheat source (eg hot water) is used, or where the conditioned area is wholly or partly surrounded by rooms held at normal temperature, a smaller temperature elevation should be sought.

4.7 In addition the plant should be made to show its capability to correct conditions and hold the room at the correct humidity with the driest outside air conditions, whilst cooling the full computer load. It should be borne in mind that the plant may dehumidify the air during the cooling cycle and this can result in a net lack of humidification capacity. Failure to achieve the test condition may also be due to vapour leakage from the building which can be demonstrated by measuring the rate of fall from an elevated moisture content with the plant shut off.

4.8 The heat required to warm the supply air during dehumidification (especially, when the computer is not operating) may exceed the space heating capacity.

Recording and alarm system demonstration

5.1 Simulated failures should be carried out to give alarm conditions and the use of test and stop buttons should be demonstrated. (Alarms should be audible to staff in the immediate area and manned points, where appropriate).

Testing the capacity of the cooling plant

6.1 The method of testing will vary according to different types of plant. In many cases it will not be practicable to run the whole refrigeration plant at full capacity for any length of time and it may therefore be necessary to run one compressor at a time.

6.2 For a chilled water system, cooling capacity can be calculated during the practical heat load test from water flow quantities and temperature differences across the cooling coils. Steady conditions must be achieved and temperature readings must be accurate as temperature differences are usually quite small. Provision should also be made for the insertion of orifice plates and thermometer pockets.

6.3 For direct expansion (DX) refrigeration systems, the cooling capacity should be determined from practical heat load tests - and not from theoretical calculations based upon compressor cylinder dimensions and cycle pressures.

Subsequent tests

7.1 While a test under simulated conditions will show whether or not there is any major fault with the air-conditioning installation, it is not possible to simulate all conditions. It is recommended that during the following year the installation be inspected when the computer is operational and the weather is very hot, and again when it is very cold.

TABLE OF FLOOR AREAS

		Description	Approx Area square metres (m^2)
(a)	(i)	Area A(1)	
		The area given is for installations having a microcomputer with a video workstation, printer and floppy disk unit assembled as a single suite. (Small systems of this kind will probably not dissipate more than 2 kW of heat).	
		Computer and peripheral equipment including storage of Magnetic Media (see notes 1 and 2).	5-10
	(ii)	Area A(2)	
		The areas given are for installations having a small processor and, say, up to 2 magnetic tape units or disks, a printer and one or two other input and output devices:-	
		Computer and peripheral equipment	10-50
		Maintenance room (see 4.17-4.19)	10-18
		Magnetic media store (see Note 2)	up to 18
		Power room (where required)	up to 12
		Air-conditioning plant room (see note 3).	up to 40
	(iii)	Area A(3)	
		The areas given are for installations having a small processor, 3-6 magnetic tape units or disks, a high-speed printer and one or two other input and output devices:-	
		Computer and peripheral equipment	50-150
		Maintenance room (see paragraph 4.17-4.19)	18-35
		Magnetic media store (see note 2)	up to 40
		Power room (where required)	12-20
		Air-conditioning plant room (see note 3).	35-75
	(iv)	Area A(4)	
		The areas given are for installations having a medium scale processor, 6-14 magnetic tape units or disks, 1 or 2 high-speed printers, perhaps 3 or 4 other input and output devices, and, say, communications equipment:-	
		Computer and peripheral equipment	140-240
		Maintenance room (see paragraph 4.17-4.19)	25-40
		Magnetic media store (see note 2)	35-60
		Power room (when required)	12-40
		Air-conditioning plant room (see note 3).	70-115
	(v)	Area A(5)	
		The areas given are for installations having a powerful processor, 15-30 magnetic tape units and disks, two high-speed printers, several other input and output devices and, say, communications equipment	

Computer and peripheral equipment	200-375
Maintenance room (see paragraph 4.17-4.19)	35-60
Magnetic media store (see note 2)	55-75
Power room (when required)	25-50
Air-conditioning plant room (see note 3).	100-150

(vi) Area A(6)

The areas quoted are typical for installations having a very powerful processor or more than one processor, many disk units, several input peripherals, printers and control for remote terminals:-

Computer room and peripherals. (This area may include separate rooms for the disks or printers.)	400-1500 or more
Maintenance room. (This area may be divided into workshop, office and storage areas or may be divided between two manufacturers). Where such areas are shared security cabinets should be provided.	35-80
Magnetic media store. (It may be desirable to store some items adjacent to the tape or disk units)	60-100
Power room (where appropriate)	25-80
Air conditioning (see note 3)	200-600

(b) Area B Input data preparation, input assembly, off line machines and despatch of output, any associated clerical work, working stocks of paper tape, cards and other stationery.	from 1 to 1½ times Area A
(c) Area C Office accommodation for supervisors, programmers and the main stationery stores.	about 50% to 80% of Area A
(d) Area D Corridors, welfare accommodation, cleaners room and miscellaneous.	This is usually about half Area A

Notes

(1) A separate maintenance room will not normally be justified but an additional area of say 6-9 sq m should be allocated to allow units to be safely repaired away from the immediate work area. This will particularly apply where a number of small systems or VDUs are co-located. Natural or mechanical ventilation may suffice but precautious may need to be taken to avoid discharges of static electricity between personnel and equipment. (see paragraphs 4.11 and 4.12.)

(2) A small number of magnetic tapes and disks might be stored in locked fire resistant cabinets in the computer room.

(3) In many instances in-room air-handling units (package units) may be installed and an extra allowance of say 2 to 3 sq m per unit should be added to the computer room floor area. One or more external cooling towers or condensers may be required.

CHAPTER ONE - COMPUTER EQUIPMENT

Central Processing Units (CPUs)

1.1 Modern mainframe Central Processing Units (CPUs) are usually housed in metal cabinets up to 2 m high, each occupying a floor area varying from 0.5-8.0 square metres (m^2) and are commonly arranged in rows or "suites". The arrangement of the suites may be subject to limitations, but these are rarely onerous and may be no more than that certain cabinets should be within a few metres of each other (data cable length limitation) with electrical connections below the raised platform floor. Smaller computer systems often house the CPU and some peripherals such as magnetic disk and tape units, within the same cabinet.

Peripheral Devices

1.2. Most peripheral devices should be in the same room as the CPU but in some cases printers may be separated by a glazed fire resistant partition (see paragraph 3.10). They should be so arranged that the most important can be seen by an operator at a console. Again, the maximum distance between certain devices may be limited. Different considerations apply to multi-access equipment having terminals at remote locations and connected either by GPO lines or special links.

Cooling

1.3. Electronic components within the cabinets are normally cooled by air which is circulated by fans. Under these circumstances room air usually enters through louvres along the bottom edges and, usually, through dust filters provided as part of the equipment. Warmed air is invariably ejected from the tops of the cabinets into the room. Some CPUs and clusters of peripherals may create localised heat densities in excess of 1 kilowatt per square metre (kW/m^2). An increasing number of large CPUs are directly cooled by air, water or other coolant - so there may be a need to provide additional services.

CHAPTER TWO - ACCOMMODATION REQUIREMENTS

Selection of premises

2.1 Accommodation for computer-based systems may present special problems, because of restrictions by local authorities or owners, on the use of office buildings for machines, by limits on floor loading or by hazards from fire, including consequential smoke and water damage. Such problems may make it necessary to find alternative, suitable, sites or buildings.

Floor areas

2.2 The table at Annex A lists various factors to be taken into account when assessing accommodation requirements. The figures quoted are approximate and depend on the type of installation as well as the shape of the site but they illustrate the proportions of the area required for each of the different parts of an installation. For convenience an installation is shown as comprising four areas. Area A (for which six different examples of installation are quoted) is for the computer, its peripheral equipment and associated services. Area B, for data preparation, is shown separately because it depends upon the nature of the task and the organisational need for it to be done at a particular place. Area C, allotted to programmers and for stationery storage may also vary widely from one installation to another because of differences in the nature of the work at each. Area D (frequently underestimated, particularly when computers are used during the night and staff engaged on shift work require additional facilities) is for welfare and miscellaneous requirements.

2.3 The examples are not Standards. Each project must be considered separately so that accommodation can be provided to meet the needs of that application. For example, where a relatively small computer configuration is to be accommodated (Area A) the areas required for the data preparation (Area B) ancillary offices (Area C) and welfare accommodation (Area D) may need to be proportionately larger, depending upon the application. Some areas may not be necessary.

2.4 In assessing the suitability of an area the space required for work-tops, trolleys, chairs, maintenance clearance, door swings, and the like, must not be overlooked.

2.5 The rearrangements and additions that may prove desirable or necessary when the installation is fully operational cannot always be foreseen and unless there are other positive plans for the future, an allowance of 30% should be included in the plans for the expansion of the computer, its peripheral equipment and the ancillary services. Even this may not allow for parallel running of a future replacement system since only compatible systems will allow piecemeal replacement.

Floor loading

2.6 Some items, in particular mainframe computer equipment, may impose a floor loading as high as 12 kN/m^2 measured within the base area of the cabinet. Where cabinets are mounted on legs (with or without castors) the 'point' loading may be as high as 450 kg, with floor pressures under the feet of up to 1 MN/m^2 or casters of up to 7 MN/m^2.

2.7 The average floor loading measured over the whole floor area of a computer room is unlikely to exceed 1.5 kN/m^2 for the computer plus 0.5 kN/m^2 for the false floor and supports. The highest loading is in the paper store where the average floor loading with conventional racking may be 6 kN/m^2 if the space is fully used. In many modern office buildings a much lower limit is enforced; 3 kN/m^2 is common but in some it is as low as 2 kN/m^2. The use of spreading plates or joists may be necessary. Expert advice on these structural aspects should be obtained.

Height of rooms

2.8 The greater the height of rooms the easier it is to provide good lighting and ventilation, to meet cabling requirements and to give access for installation and maintenance. The desirable minimum height in the air-conditioned area, between the finished floor and the suspended ceiling is 2.6 m and this may require a height between the structural beams and the structural floor of not less than 3.3 m where floor and ceiling voids are employed for the provision of ventilation and for wiring.

2.9 For larger installations and installations where the concentration of generated heat is high, the height between the finished floor and suspended ceiling should be increased to at least 3.6 m for areas of, say, 300 m^2 and upwards.

Access for installing the equipment

2.10 Manufacturers usually deliver equipment in open crates covered with polythene sheets and prefer to unpack them in the computer accommodation to safeguard the equipment from dust, dampness, mechanical damage and the effects of weather. Since this is likely to free some dirt preliminary unpacking should be done before entry to the computer room.

2.11 The width of any corridors along which the equipment must pass must be adequate and any problems of cornering should be discussed in advance with the contractors. Stairways and elevated link corridors may need temporary support and the load carrying capacity of lifts should be checked, again in advance. The delivery route may be through the Engineer's (or other) room in which case the unpacking can take place here yet be within an air-conditioned space. In this case the door positions should be such as to lie opposite a natural corridor through the room to allow the passage of equipment in the future with a minimum of disturbance.

Layout of accommodation

2.12 Ideally, rooms should be arranged to meet the job workflow, but the following should be borne in mind:-

(a) the Computer Room is the focal point but may take up less than 20 per cent of total floor area. The rooms most intimately associated with the Computer Room and which should adjoin it are:

magnetic media store (paragraphs 4.20 to 4.26);

working stationery store;

job assembly room;

supervisor's room (if required);

maintenance room (see sub-paragraph g below);

telecommunications/telephone exchange room;

sink facilities (see sub-paragraph m below);

viewing facilities (see sub-paragraph c below).

(b) To reduce dust, noise and fire risk in the Computer Room, the off-line paper equipment should be outside.

(c) Viewing facilities allow interested people to see the machine without entering the working area. A double glazed "borrowed light" in a corridor, one or both sides of which should be of wired glass, will often suffice but if parties are to be accommodated, a room with a platform raised, say, 1 m, should be provided. However, it should be noted that this facility will impose a security risk and is not recommended as a standard feature.

(d) Plant and power rooms are noisy and the requirements of paragraphs 3.24-3.26 apply. However, the engineering and air-conditioning is simplified when they can be sited near the computer room.

(e) Rooms in Area B include input data preparation, the mounting and despatch of output, any associated clerical procedures and for holding the working stock of paper tapes, cards and other stationery. Special provision may be needed for storing 'security' classified stationery (ie Safe or Strongroom).

(f) The bulk stationery store (see paragraph 4.27) should be outside the computer suite. When the quantity of stationery is very large and in bulky packages, a loading platform, wide corridors and suitable doors will facilitate handling. Where the traffic in printed output will be considerable, trolleys should be used. The route between the loading bay, stores and usage area should be free from steps; and doors (preferably auto closing swing type) should allow easy passage in either direction. Fully automatic doors may be justified where the traffic is heavy. Stationery transfered from this store to the computer area should be allowed to acclimatise before use.

(g) The Maintenance room should, where possible, be on the equipment delivery route to permit the equipment to be unpacked outside the computer room and minimise contamination.

(h) Air locks should be provided at entrances to air-conditioned rooms, unless the traffic will be small. They should be long enough to accommodate a trolley.

(i) Programmers' accommodation should be free from noise and bustle. It should be away from the computer room - even in a separate building. A terminal room for programmers' use, and access to a conference room with a blackboard is often useful both for internal purposes and for briefing parties of visitors.

(j) Staff welfare accommodation should be provided outside the computer area, particularly for night shift working. Provision should be made for keeping outdoor coats and personal items away from the conditioned area. Appropriate toilet ratios for male and female staff and the disabled should not be overlooked.

(k) Fire separation within the computer area by fire resistant partitions and doors is a necessary precaution for the protection of

    unique records or vulnerable equipment, eg:
        computers (and associated recording devices);
        original records;
        special duplicate tapes;
        magnetic media libraries;
        job assembly (input, preparation, despatch) and data preparation;

    and against hazards that arise inside or outside the installation from

    equipment, uses or processes with a risk of incipient or developing fire, eg:
        oil filled electrical equipment (outside the suite);
        maintenance work;
        special printers;
        working stationery stores;
        waste paper stores;
        paper shredding; and
        offices.

    Structural fire precautions are summarised in sections 9.7 to 9.11

(l) Means of escape from fire should be via corridors and intercommunicating doors, so arranged to provide alternative routes to safety from any room, bearing in mind that windows would not normally be available for emergency exit.

(m) Where COM (Computer Output on Microfilm) equipment is to be installed, there will be a minimum requirement to provide a sink with a water supply and suitable drainage facilities for washing items of equipment associated with film processing and disposal of chemical waste. For separate film processing the water temperature may need to be controlled and to be supplied at adequate pressure. The sink should be outside the computer area and conveniently located.

(n) The location of, and access to, any complementary administrative block should be considered when planning an installation.

Physical Protection and Security

2.13 Because a computer invariably represents a considerable financial investment in its own right and a concentration of information storage and processing of varying degrees of privacy or security, it may be necessary, at some installations, to provide special physical protection and security measures. In general terms additional protection of the power supply, telecommunications system and environmental control equipment may be required to protect against vandalism or deliberate interference. Sensible planning, say by locating the installation away from 'public' areas and wrapping the computer suite with offices will give added protection. If the installation will be adjacent to and/or overlooked by roads, railways etc a critical review of its location may be necessary.

2.14 To protect against unauthorised entry to the computer area an Access Control System should be installed. To ensure the integrity of the installation, particularly during the silent hours, an Intruder Detection System should be fitted and should raise an alarm either within the building and/or externally depending on the circumstances. It is advisable, wherever extra protection measures are considered necessary, to seek specialist advice.

CHAPTER THREE - ENVIRONMENTAL CONDITIONS

The building

3.1 The load on the air-conditioning plant will be considerably reduced and control enhanced if windows are kept to a minimum and double glazed.

3.2 The dew point of the air in the conditioned space is normally 10°C but will be higher at the upper limit of control tolerance. Unless double glazing is fitted and unless the frame is well insulated condensation will occur in winter. There is a considerable vapour pressure difference between the room and the outside in summer and winter conditions. If additional glazing is added to existing windows condensation will occur on the outer windows unless the inner windows are vapour sealed. Draught proofing is not sufficient.

3.3 The conditioning plant will be subject to large additional latent loads and may be unable to control the room conditions if the building is not air- and vapour-tight because there will be a considerable moisture loss in winter and gain in summer. It is advisable to seal the structural ceiling, walls and floor completely, preferably with a plastic sealer. This will also make this area dust free. Untreated builders' finishes may produce dust, leak air and vapour, and will make it impossible to clean the area satisfactorily.

3.4 Where there is to be a ventilated ceiling adjacent to a roof it is particularly important to give a good thermal insulation (U) value to the loft (a minimum of $0.35W/m^2{}^\circ C$) preferably with insulation in the underside of the roof slab to prevent the slab acting as a "heat sink" and avoiding the formation of condensation.

3.5 The air-conditioning plant and its maintenance is very important and its accommodation must not be reduced below the requirements of the design engineers. It should be neither inconveniently sited, nor given sub-standard access for maintenance. The room should be of a size suitable for the initial plant capacity plus an appropriate allowance for future enhancement.

General

3.6 The computer accommodation should be free from excessive vibration, air pollution, dust, noise, electro-magnetic radiation, mechanical shock and risk of fire. Ideal conditions are not easily attainable in city centres and industrial areas, where high accommodation costs tend to result in cramped conditions. In modern buildings ceiling heights and floor strength are often unsuitable for the larger computer installations and the users sometimes have a choice between the ground floor or the basement. The former is to be preferred to avoid the risk of damage from external floods, faulty plumbing and interference from underground services.

3.7 A road, or railway, within a few tens of metres will not normally give rise to vibration sufficient to cause trouble to the equipment. Consideration should however, in any case, be given to the needs for the physical security of the computer, records and plant. (See 2.13-2.14)

Dust

3.8 Structural concrete, brickwork or other dust-producing surfaces beneath false floors or above suspended ceilings should be sealed by applying a solution of polyurethane, rubber based paint, sodium silicate or similar preparations. In the ceiling void a plastic spray should be used. Where paint solvents create a flammable atmosphere appropriate precautions should be taken to minimise the fire hazard during application. The finish of walls and ceilings should be free from flakes, chips and chalking: materials such as glass or mineral fibre tiles that might produce abrasive particles, or floor coverings that crack or crumble, or shed fibres, should be avoided. Impregnated mats at each entrance, laid when the internal fabric of the building is completed, will reduce the dust brought in on shoes. The mats should be recessed in a frame to prevent rucking.

3.9 Dust between the magnetic tape and the reading and writing heads on a tape unit may cause errors in reading from or writing onto the tape and in addition may permanently damage the tape. Dust between the surfaces of a disk and the "flying" heads can cause head to disk intereference with possible scoring of the recording surface or damange to the head. Dust filters, where fitted on tape units, prevent entry of only the larger dust particles. Unfiltered particles can still lead to read/write problems and may increase wear of the heads or the magnetic medium. Moreover, when a disk or tape unit is opened to mount or remove disk packs or tape reels, dust may enter; sources of dust in the computer room should therefore be minimised. Disk units which use semisealed disk and head assemblies ("Winchesters") are inherently less susceptible to dust but care must be taken not to allow the integral filters to become clogged.

3.10 Paper used by printers will produce dust. Where large volumes of printing are involved, it is good practice to locate the printers in a separate, glass partitioned, area within the suite, to minimise the spread of dust. If this is not possible printers should be positioned as far away as practicable from disk and tape units.

3.11 Fabrics used for sound attenuation or decoration should be as lint-free as possible. If fibrous material is used for insulation of ducts it should be wrapped in metal or PVC sheeting and all joints and edges carefully sealed.

3.12 The air-conditioning plant, which should be thoroughly tested and commissioned before installation of any computer system, should provide a slight positive air pressure of about 25 N/m^2 (equivalent to 2.5 mm water gauge) in the air- conditioned area; this helps to prevent dust entering and reduces the penetration of smoke from any fire that may develope in adjacent areas. In fully conditioned areas windows should be sealed. Sections 6.3 to 6.5 give further guidance on cleaning the installation.

3.13 Smoking in the computer room should not be allowed. Quite apart from the fire hazard, it may result in ash or smoke particles contaminating magnetic tape or read/write heads causing malfunctioning or damage. Similar considerations apply when any other magnetic storage devices are used.

3.14 Textile floor coverings should be of the needle punched fibre bonded type (see 4.11 and 4.12) and should neither produce dust nor shed fibres easily. This is particularly important where an underfloor air supply to the room is employed. Perforated type floor tiles, should not be used to supply air into the room when fitted with textile covering.

Temperature, humidity and air filtration

3.15 Sudden, cyclic changes in temperature can adversely affect the reliability of computer hardware but this can be overcome by good plant and control design. The nature of electronic components used in commercial computer systems is such that the ambient temperature should not exceed approximately 30°C. In the computer room the humidity of the atmosphere and the temperature range must be such that neither condensation can occur (high relative humidity (RH)) nor electro-static charges build up (low RH).

3.16 Unless high density recording magnetic storage devices are installed, appropriate limits for the recommended conditions in computer and maintenance rooms are temperature from 15°C to 27°C and relative humidity between 35 per cent and 65 per cent, with relaxed dust filtration requirements (see 3.23 and 11.11), although personnel comfort will dictate closer temperature control. The comfortable range is approximately 20°C to 26°C. Where magnetic storage devices are installed, closer limits are required; and temperatures of 21°C ± 3° with relative humidity of 50 % ± 10 % are recommended. (See 4.20 to 4.26 for storage of magnetic media).

3.17 When the equipment is switched off, the temperature and humidity requirements may be relaxed, but the air should be well above dew point and the room contents kept warm enough to avoid condensation. This can be achieved in the computer and maintenance rooms and in the store rooms for stationery and magnetic storage media by humidistat- and thermostat-controlled background heating (normally electric) interlocked with the air-conditioning plant to prevent both being energised together and designed to hold the room at a minimum of 18°C. If the heaters are not interlocked the thermostat should be set to control the room at about 16°C but it may be necessary, particularly with mainframe computers, to reacclimatise the room at approximately 21°C for a short period before the computer system is switched on. In both cases an overriding humidistat should be set to bring in the heating system if the relative humidity exceeds 80% (though other figures may be specified).

3.18 Such heating need not be provided where the air-conditioning plant is duplicated and designed to ensure continuous running at all times even if a major item of plant including the controller should fail. Nevertheless, socket outlets should be provided of sufficient total capacity to allow portable heaters to be connected when the air-conditioning plant is shut down, eg for maintenance. However, when the computer is switched off for long periods it is desirable in the interests of economy that the air-conditioning plant also be switched off. The plant should be switched back on an hour or so before the computer, to allow the environment to stabilise. Unattended running of the computer introduces risks of equipment damage when malfunctioning control equipment permits extreme environmental conditions. Moreover, in the event of an outbreak of fire, immediate human intervention would be unavailable. To safeguard against these contingencies where air-conditioning plant has to run unattended, alarm signals should be extended to a suitable, staffed, point.

Failing this an air-flow failure and out of limit sensors should be fitted to shut off the plant and computer.

3.19 Instructions should be given about the action to be taken if the alarm operates during an unmanned period. If the temperature has become abnormally low, the room and the equipment should be brought up to the designated temperature before the humidifier is brought into operation, otherwise moist air will condense on the equipment. For Fire Precautions see Chapter 9.

3.20 Recording and alarm systems should be provided when full air-conditioning plants are installed. At least one temperature and relative humidity recorder (thermohygrograph) should be installed in the computer room to provide a continuous record of room conditions. Preset alarms (audible and visual) should be fitted to give warning when limits are exceeded. Recorders are not normally necessary in all other air-conditioned rooms but they are useful in the media stores.

3.21 Sensing elements should be sited in a position representative of the desired room conditions, free from the immediate effects of air supply conditions and shielded from sunlight as well as heat dissipated by the equipment. Recording charts should be made available to the computer manager and maintenance engineers since they may be of assistance when inquiries are made into computer faults.

3.22 Even where surfaces are carefully selected and rooms are regularly cleaned the movement of staff and some processes will produce airborne particulate matter (dust) directly into the space. This cannot be eliminated entirely by air filters in the air-conditioning system but dilution is achieved depending on the air change rate. Air filtration is required to control the quality of the air supplied to the space and has to deal with dust in both the fresh and recirculated air.

3.23 Unless a high standard of cleanliness is specified, air filters with an average arrestance of 80% to Eurovent 4/5 standard (ASHRAE 52/76) should suffice. Where a higher standard of cleanliness is required, the computer manufacturer will normally specify the filtration efficiency or a dust count to be achieved within the room, but in the absence of this detail, the standards required for a class 4 environment to BS 5295 should suffice. To achieve this higher standard the main air filters should have an average atmospheric dust spot efficiency of not less than 90% to Eurovent 4/5 (efficiency of not less than 75% to BS. 3928). For these filters, a prefilter with average arrestance of not less than 80% should also be fitted.

Noise and vibration

3.24 Accommodation free from external noise and vibration has been recommended. Within the building, noise and vibration may arise from card handling equipment, printers, electric motors and generators, fans, pumps, compressors, standby power generators, air movement in ventilation units and ducts, etc. As noise and vibration from refrigeration plant compressors, standby power generators and main ventilation fans can be particularly troublesome, attention should be given to the correct selection and siting of equipment, and appropriate anti-vibration measures. The design aim for the noise level in the computer hall from the air-conditioning plant should be NR50 or less. A reverberation time of 1 second or less is desirable.

3.25 Architect, engineer and user should co-operate to achieve a layout, subject to technical and operational needs, that provides for sound absorption and minimises noise transmission within the building. Where the site is in a residential area, or where a specially designed system is used, special acoustic treatment and/or the addition of silencers may be necessary to limit the noise from fans, air inlets and exhausts, condensers and cooling towers. British Standard 4142; 1967 provides methods of assessing the potential annoyance caused by noise in mixed industrial and residential surroundings. Acoustic treatment of ceilings and exposed areas of walls surrounding a noise source reduces internal reflections, limits the build-up of noise and so reduces its transmission through voids or the building fabric. Rooms used for printers should be treated; but small rooms are difficult to quieten.

3.26 The acoustic materials used should neither produce dust nor be combustible. Use of acoustic tiles that are fragile and which, when broken, produce dust, should be avoided. Suspended ceilings and any decorative linings should be non-combustible. If a mineral fibre or fibre-glass filling or backing is used it must be contained in a completely sealed PVC, or similar, bag.

Electromagnetic and Radio Frequency Interference

3.27 The satisfactory operation of computer equipment may be prejudiced by stray electromagnetic and radio-frequency interference (EMI and RFI respectively).

However, most computer buildings will attenuate interference by a factor of about 10, provided that there are no windows and this may be sufficient to reduce such interference to an acceptable level.

3.28 Many natural phenomena and man-made devices may produce Electromagnetic or Radio Frequency emissions causing intereference (EMI and RFI) at levels which may cause malfunction of computer equipment and this must be taken into account when selecting a site for computer accommodation. The principal natural phenomena which can prove troublesome are atmospheric noise and thunderstorms, of which the latter present the greater risk in UK. However, providing that building metalwork is earthed and that lightning conductor(s) do not pass through the computer hall, then any problems should be minimal.

3.29 Any equipment or system in which radio-frequency power is generated (intentionally or through secondary effects) or in which current is switched, can produce RFI. Its influence on a computer depends upon the frequency and strength of the RF field produced in the computer hall. In general, for satisfactory computer operation the field strength of radiated interference should not exceed 1.5V/m over the frequency range 10kHz - 3 GHz, though in some applications the computer supplier may specify a lower field strength.

3.30 When a site for a new computer installation is under consideration the possibility of interference, by plant or installations of the types and within the distances listed in the table below, should be investigated. The presence of any large radio/radar aerial structure, static or moveable, will indicate a possible source of interference. Sources of RFI which are most likely to prove troublesome and their respective distances from the site within which it is possible that field strengths may exceed acceptable values are listed below.

Source	Range of interference
Radar transmitters	10 km
Satellite transmitters	2 km
Radio/TV/communications transmitters (fixed)	2 km
Radio beacons	1 km

Overhead electric power lines	200 m
Arc welders	100 m
Mobile radio transmitters	50 m
Electric railway lines	50 m

3.31 Some other possible sources of interference which may cause problems at distances of 25m or less are ultrasonic equipment, medical electrical/electronic equipment, spark-ignition engines, power switching devices (both solid-state and mechanical) and industrial and domestic machines driven by electric motors (eg vacuum cleaners). Further possible sources of interference are:-

airfields (including aircraft approach paths);

dockyards (including adjacent shipping lanes);

hospitals;

military establishments;

police, fire and ambulance HQ stations;

British Telecom radio installations;

power stations and large switching stations; and

heavy industrial areas.

3.32 If the peak radiated power of radio, radar or TV transmitters is known, or can be established, the approximate field strength at a prospective site can be estimated using the following formula:

$$E = \frac{\sqrt{30p}}{d}$$

where E = field strength in Volts per metre (V/m)
p = peak radiated power in Watts
d = distance from aerial in metres

3.33 If this calculation indicates that there is a possibility that the interference field strength may exceed 1.5 V/m, or in case of doubt, it will be necessary to measure the RFI field strength on the site. Such measurements should cover the frequency range 10kHz -3GHz but if necessary additional spot measurements should be taken at the frequency of any installation which may be a potential hazard, (eg a radar transmitter) whatever its frequency.

3.34 If measured, or probable, future RFI levels exceed 1.5 V/m, principal remedies to be considered, singly or in combination, are:-

(a) remove or resite the source of interference;

(b) screen the source of interference;

(c) screen the computer installation;

(d) resite the equipment.

Measures (a) and (b) will often be impracticable, (particularly where interference is caused by radio transmitters) so that (c) and/or (d) may have to be implemented. Where the problem occurs at a new site, it will often be best to seek an alternative if possible, as screening is costly; but if no suitable alternative can be found, or if the problem occurs at an existing site, specialist advice on the provision of screening should be sought.

Cleaning computer accommodation

3.35 Even in air-conditioned accommodation, some dust is introduced by clothing and as a result of handling paper. Regular cleaning within the room is therefore necessary. The larger installations will often have a centralised vacuum cleaning system built-in; in others a vacuum cleaner with a high quality filtration bag should be used.

3.36 The use of water for cleaning in the computer room, should be restricted to hard surfaced floors and, when necessary, the furniture; its use should be strictly supervised. A water-based polish (either metallised polymer or acrylic emulsion) is preferable to a solvent-based wax polish and under no circumstances should they be mixed, or a change made from one to the other without the original polish first being completely removed, since otherwise surfaces can become slippery and powdering of polish can occur. In some instances the polish may need to have antistatic properties to keep the electricial resistance of the floor below an acceptable maximum value (see paragraph 4.12).

3.37 In general, only impregnated mops and dusters should be used, particularly on the plain, outer surfaces of units comprising the computer system. Cleaners should be instructed not to dust the switch areas of a computer unit or console.

3.38 Carpeting (see 4.11) should normally be vacuum cleaned. Any other cleaning treatment should be strictly in accordance with the carpet suppliers' recommendations since its antistatic properties are likely to be adversely affected by water and shampoos.

Commissioning and testing

3.39 The air-conditioning plant should function satisfactorily before installation of the computer. Comprehensive commissioning and testing of the complete air-conditioning installation should be carried out when the building and plant are complete and before the computer is brought to site. (See Chapter 6 and Annex B) Three to eight weeks, as appropriate to the size of the installation, should be allowed for this work (see 8.9 to 8.14). After satisfactory commissioning of the air-conditioning, the final design, installation and commissioning of any automatic fire protection equipment should be completed.

CHAPTER FOUR - COMPUTER ROOM

Layout

4.1 A rectangular room (having, say, length to breadth in the ratio 3:2) free from columns allows for the most convenient and least restricted layout of equipment. 'L' shaped rooms impose restrictions: long narrow rooms should be avoided. To provide access to the equipment for maintenance engineers, manufacturers specify a clearance, usually of about 1m to be left at the front, rear and sides of suites of equipment and of individual items of peripheral equipment; this should be observed.

4.2 Within the machine area of large installations, segregation of magnetic devices not requiring frequent operator intervention, or of printers, can be provided by partitions or separate rooms. If partitioned off, such devices are kept in a cleaner environment; if in a separate room, the more noisy and dust producing items are separated from the remainder. Operating requirements will have to be satisfied and either approach may dictate the use of additional means of communication.

Floors and floor voids

4.3 In providing accommodation for any computer system a modular platform floor is highly desirable and for mainframe computers it is essential. Modern platform floors can serve two purposes: to provide convenient voids through which to run cables and services; and as air distribution plenums. The minimum underfloor clearance for a mini-computer is 100 mm, increasing to a minimum of 300mm for a mainframe computer or if the floor void is to be used for air distribution. This should be increased to 600mm in large installations and installations where the concentration of computer heat is high. Normally, platform floors need to be installed in computer equipment areas, but where future expansion is anticipated, platform floors can be extended into adjacent store and office areas to simplify any future conversion of the accommodation.

4.4 It is recommended that platform floors comply with the appropriate grade specified in the Property Services Agency's "Performance Specification - Platform Floors": MOB 01.801 (available from PSA Library, Sales Office, Block C, Whitgift Centre, Wellesley Road, Croydon, Surrey). Such floors, when tendered for a particular requirement, should be accompanied by a full test report as outlined in the specification. Additional information is also contained in PSA's "Technical Guidance - Platform Floors" MOB 01.707 (March 1982) available from the same address.

4.5 If computer accommodation is to be provided within an existing building, the use of a platform floor will require ramps to allow for the change of level to other areas. If the gradient of the ramp has to be greater than 1 in 10, a non-slip surface should be provided.

4.6 In a new building the structural slab should be at a level such that the platform floor is at the same level as the floor of the remainder of the accommodation, once positioned on the floor jacks. Floor jacks require a reasonably true and level subfloor on which to stand. Suitable proprietary floors are available from a number of firms who specialise in this work and which will supply and lay them.

4.7 Proprietary floors consist of prefabricated panels of timber and metal usually 0.6 m x 0.6 m and 25-50 mm thick. These are usually supported on adjustable pedestals which are fixed to the sub-floor. The panels are normally located and supported by jacks at the corners only but in some cases "stringers" ie horizontal members, span the pedestals to support the edges of the panels. Where jacks are the sole means of support, care should be exercised when removing a number of panels to avoid an "island" which is potentially unstable. The weight of the false floor itself does not normally exceed 45 kg/m^2.

4.8 Most "Heavy" grade proprietary floors can support point loads of up to 450 kg. A type test certificate should be available and should state the deflection under load. This load caters for the majority of computer equipment but should be checked with the computer manufacturer. It is usually possible to cater for heavier loads if required by installing additional floor jacks locally, or stronger panels generally. Wooden floor panels should be faced on the underside with non-combustible material having secure mechanical or other approved fixing.

4.9 The structural concrete and brickwork beneath the platform floor should be swept and sealed with a heavy bodied paint to prevent dust being shed and entering the computer room.

4.10 Floor tiles under equipment must be cut to allow cables to pass through them. On receipt of a tile layout drawing from the flooring sub-contractor, the computer manufacturer will detail the holes to be cut. The cuts should be sealed with edging strip to cover sharp edges and prevent tile material from shedding. Cut tiles may require extra supporting jacks to sustain the equipment load.

4.11 The floor finish in computer rooms should be hardwearing, easily maintained and should neither produce dust nor shed fibres easily. Anti static vinyl, melamine surfaced high pressure laminate or an anti-static needle punched fibre bonded carpet is recommended. Any tile edging protruding to the upper side of the tile must be non-metallic.

4.12 The electrical resistance from the top surface of the finished floor to the building earth should be between 5×10^5 and 2×10^{10} ohms. This ensures a resistance to earth high enough for electrical safety, yet not so high as to prevent static charges from leaking away.

Lighting

4.13 Lighting in computer rooms needs careful planning to provide operators and maintenance engineers with sufficient light in the right places without excessive contrast or glare. For general illumination, large area lights which minimise glare and shadow are preferable with an illumination of at least 500 lux, and Limiting Glare Index of 19. In areas where video display units (VDUs) are used, a level of 350 lux with a Limiting Glare index of 16 is more appropriate. Local task lights are often desirable where operators need to read data from documents.

4.14 Interior decoration on surfaces should not be brightly coloured and should reflect light; matt finish pastel colours are preferred. The ceiling also should be lit adequately. In purpose built installations the use of external windows for provision of light should be avoided where practicable except where unavoidable light and solar heat gains can be controlled by blinds (external blinds provide better solar protection than internal) and/or solar reflecting film.

4.15 The following publications give useful information on the subject of lighting:

(a) Chartered Institute of Building Services - Lighting Publications;

(b) British Standard Code of Practice No 3 on Lighting - Part 1; 1964, Part 2; 1973.

(c) British Standard BS 5266 Part 1 - The Emergency Lighting of Premises.

Fittings and furnishings

4.16 The following should be used to minimise the amount of combustible material in computer rooms:-

(a) mainly metal furniture and fittings, including tables, chairs, cupboards and the like;

(b) metal waste paper bins;

(c) metal open bins or containers in which to collect paper from machines.

Only essential equipment should be placed in the computer room.

Maintenance room

4.17 The computer supplier will specify the accommodation required by his maintenance personnel. In relatively small installations the engineer is unlikely to be resident but would still require a room with some of the facilities mentioned in 4.18. In very small installations he may require nothing more than a lockable storage cupboard.

4.18 At larger installations the supervising engineer may need a separate office. Adequate lighting, power points, work benches, cupboards, tables and chairs should be supplied. The bench and one or more cupboards may have to be to the computer manufacturer's specification. At such installations the environment should be to the same standard as in the computer room unless the particular manufacturer allows a wider tolerance. The size, siting and access to the room is mentioned in paragraph 2.12 and Annex A.

4.19 The power distribution unit for equipment may be sited in this room together with remote control of the motor alternator set(s) if any. The engineer's need for a 24 hour external telephone connection should not be overlooked. In some instances a telephone between the maintenance or computer room to the power equipment room may be necessary. (eg for setting-up controls)

Stores for magnetic media

4.20 The environment of the operational store should be the same as the computer room. For convenient access, the store should be adjacent to the computer room. The door to the store should allow easy access for a trolley. Reels of tape should be stored in slim-line cannisters, rim seals or autoload collars and housed in the appropriate racking. The size, siting and access to magnetic tape stores are mentioned in 2.12 and Annex A.

4.21 To ensure that records can be re-constituted in the event of the loss of media located near the computer, archival copies of tapes holding programs and sufficient back-up data for effective reconstruction, should be stored in a separate building. The environment should be controlled as in the computer room but with a tighter and lower Relative Humidity level of 45% ± 5%.

4.22 Where unrecorded tapes/diskettes or recorded/unrecorded rigid disks are stored in their correct protective covers but away from the computer building, the environmental conditions (other than structural fire precautions) for their storage may be as for an office. Background heaters, controlled by humidistat and thermostat should be provided to keep humidity below 65% and temperature above 15°C, but the media will not be permanently harmed if, over short periods, the conditions go beyond these limits. The media should be allowed to acclimatise in the computer room for up to 24 hours before use.

4.23 Where a separate operational store is not practicable or necessary (eg small computer installations) the media should be stored in the computer area but with additional archival facilities as described in 4.21.

4.24 Where it is necessary to frequently update intermediate generation tapes, consideration should be given to the installation of a fire safe in the computer area, but this will not necessarily safeguard the tapes against a major fire.

4.25 The number of wall fittings and architectural features should be minimised and positioned to give the maximum wall space for storage racks which may be up to a height of some 2.5 m in the case of high rooms. With purpose built racking, approximately 250 tapes or 15 disks per sq m can be accommodated.

4.26 Magnetic fields are generated by electrical equipment and machinery although field strength reduces rapidly as distance from source increases. Magnetic fields in excess of 200 Oersteds are normally required to erase or corrupt magnetic tapes or disks and since small electrical devices, such as hand drills or vacuum cleaners, generate only about 10 Oersteds they will cause no discernable erasure. Lift machinery, switch gear, transformers, motor generators, lightning conductors and other high current carrying equipment can on the other hand generate much higher magnetic fields and recorded magnetic media should not be stored adjacent to these or the electrical conductors associated with them. Permanent magnets can present an even greater hazard. Even those used on door latches or flashlight holders and the like, can have field strengths of up to 1500 Oersteds. However the field strength is considered insignificantly low at a distance of 10cm or more.

Stationery store

4.27 The air-conditioned area should provide space for stationery sufficient to ensure that for at least 24 hours before use it reaches the same temperature and humidity conditions as in the computer room. If this provision cannot be made for the total stock a separate store should be provided for a bulk stock. This should maintain temperatures between 16°C and 26°C and RH between 30% and 65%, but even within this range, abrupt changes of humidity should be avoided. Sustained exposure outside this range may result in permanent damage.

4.28 All stationery should be stored in boxes as supplied by the manufacturer, either unopened or sealed again after opening. Shelving used to support boxes should be strong. Boxes should not be stacked more than three high nor should heavy weights be put upon them.

CHAPTER FIVE—AIR- CONDITIONING

Factors determining air-conditioning capacity

5.1 Computer equipment and peripheral items are the main sources of heat in a computer room, the amount of heat dissipated, for all practical purposes, being the same as their electrical power consumption. To this should be added a substantial margin for expansion or parallel running - see paragraph 2.5. Other factors to be taken into account in determining the air-conditioning capacity are: heat gains and losses through walls, ceilings, windows, door openings and glass partitions; heat dissipated by the lighting, the staff working in the room; and the need to condition the fresh-air intake. Heat gains and losses through windows can be reduced by double glazing. Roof construction immediately above the computer accommodation should be well insulated. A light colour externally, particularly white, helps to reduce solar heat gain. The conditioned space should be of air and vapour-tight construction.

5.2 The outside conditions recommended for design purposes for the Midlands and South are 30°C dry bulb, 20°C wet bulb for summer and -4°C saturated for winter. For North of England and Scotland local conditions should be taken into account.

Design authority and contractors

5.3 The design authority for the air-conditioning installation should have considerable experience of air-conditioning practice and preferably of air-conditioning for computer installations. It is important that the contractor should be fully conversant with this type of work, even when the cost is quite small.

Selection of Air- Conditioning Plant

5.4 Although a suitable environment for very small computer systems (ie where the heat load is low) may often be achieved for a high proportion of the year by natural or mechanical ventilation, under winter conditions, when the outside moisture content will be very low, the relative humidity inside the computer room will fall below 20% and static electricity discharges may become a problem. Raising the RH by means of a humidifier, or provision of an antistatic floor covering, can overcome this but the latter may not be effective at relative humidities much below 30%.

5.5 For slightly larger systems (say where the heat density exceeds 100 W/m²) cooling plant may be needed to limit the temperature rise particularly during summer. Compact air handling units are available which are capable of cooling the fresh- air as it is introduced to the room and cooling, or warming, the air as it is recirculated. They may be self-contained in the smaller sizes, and have integral compressor/condenser units, but do not normally provide integral humidity control. They may be installed in a window space. Larger units may be fastened to any wall or mounted on an exterior wall for minimum intrusion into the room. They may be of the integrated form but are more generally connected to a remotely sited condenser unit. Integrated humidification control is not normally incorporated but free standing humidifiers can be installed (although a water supply and drain will be required).

5.6 With increasing heat loads (say systems producing heat densities in excess of 200 W/m²) it may be more economical to invest in a "packaged" air conditioning unit, than in two or more of the smaller cooling units. Packaged units are more complex, either standing against a wall or freestanding and incorporating all the functions necessary to maintain room air within tight temperature and humidity limits, whilst providing filtration for the recirculating and fresh-air. They are generally less than 600mm in depth and are able to project conditioned air across a room at a height above that of a system unit. They can also supply air to a plenum below a platform floor or above a suspended ceiling which form a highly adaptable air distribution system. Such units must, however, be provided with shut-off dampers on the supply and return air connections for isolation purposes.

5.7 When these units are installed in the computer room additional floor area should be provided so as not to reduce the usable computer area.

5.8 The coolant for packaged units can be either chilled water or refrigerant (DX systems) normally supplied from remote chiller/compressor units. A mains water supply and drain for the humidifier and condensate and an external area where the cooling towers/condensers can be sited should also be available.

5.9 In conjunction with in-room packaged units, relatively small central station equipment with distribution ductwork can be used for humidity control, fresh-air, pressurisation and to maintain minimum conditions when the computers are not operating. Central station air-conditioning plant is often used when the heat load is high but packaged air handling units are now equally adaptable for these applications.

Location of Air-Conditioning Plant

5.10 The siting of the plant room is restricted by the size and weight of the plant, the noise and vibration it causes, air trunking requirements, the need for air intake from outside the building, and for access to drains to take waste water from the plant. If a computer is likely to be used at night or at weekends the noise made by the air-conditioning plant outside the building should be minimised. The engineer and the architect should co-operate in planning the air-conditioning arrangements. This may not only actually reduce the length of duct runs inside the building but improve the operational efficiency of the plant.

5.11 The fresh-air intake should be situated to utilise the cleanest and coolest air available. Intake of air should be avoided from over flat roofs or other large flat surfaces heated by the sun, or from the slip-stream of any adjacent chimneys, or where there is a risk of drawing in fumes from vehicles, kitchens, boiler houses, fuel intake points or smoke from any external fire.

5.12 The plant layout should permit easy access for the maintenance staff to all parts and allow space for additional plant arising from any changes to the computer installation and for standby power equipment (see also 7.16 to 7.20).

Air Distribution and Ducting

5.13 The distribution of supply and return air depends on the particular computer equipment and heat densities involved and can be catered for by one, or possibly a combination, of the following methods:-

(a) overhead supply from a plenum through perforated ceiling tiles with return in the floor void and/or sidewall grilles;

(b) overhead supply through diffusers, linear grilles, slots or ceiling tiles supplied by ducts with similar return;

(c) under floor supply through floor grilles with overhead extract; and

(d) direct underfloor supply into computer cabinets with overhead extract.

Method (a) will not work satisfactorily for low air volumes and one of the methods in (b) is likely to prove more successful.

With method (d) computer manufacturers impose limitations on the temperature and moisture content of the air for the protection of the computer and the prevention of condensation.

5.14 Ceiling plenum depths will depend on required quantities of air, but they must be sufficient to minimise turbulence and limit velocities in local areas eg, under beams etc. Raised floor voids should normally be at least 300mm deep and may need to be greater depending again on air quantities required.

5.15 The air handling plant serving the computer area should not be shared with the other areas of the same building. The air filters should be "flameproof" as classified under BS 3119 and satisfying BS 3120. They should be positioned so that the downstream duct is at positive pressure.

5.16 Where it is essential to use insulation on the inside of ducting, either for thermal or acoustic purposes, it should be non-combustible and should not encourage production of dust, nor corrosive or toxic fumes when heated. Ventilation duct work should be of metal. Insulation on the outside of ducting should preferably be similar, but combustible material may be used provided it is protected by a covering of plaster or rendering held in place by wire netting or by a material having similar performance in fire. Such insulation when provided on ducting or piping within the air-conditoned space must not produce dust.

Standby Facilities and Maintenance

5.17 Air-conditioning is essential for the correct operation of computers that dissipate more than a few kilowatts of heat. Breakdown of plant can cause complete disruption to computer operations and it is therefore necessary within the design, selection and location of plant to provide some standby facilities for operational reliability - especially where continuous operation of the computer system is essential. The duplication of vulnerable plant or the installation of multiple packaged air handling units can normally, with the addition of a spare unit(s), provide the necessary reliability.

5.18 Periodically, parts of the air-conditioning plant will have to be withdrawn for maintenance and overhaul and if a serious failure occurs, replacement of a major item may take weeks or even months. Minimum spares to be held on the site include fan belts and filters; the provision of other spares should be considered in relation to the supply position and the importance of the computing facility.

5.19 If a separate fresh-air plant is used it should have duplicate central station air handling units provided with filters, cooling and heating coils, supply fan and humidifier. The extraction system associated with the fresh-air plant should be provided with duplicate fans. The central chilling and condenser equipment should be provided with standby equipment ie chillers, pumps and cooling towers, but where secondary areas such as offices are served by the same plant, the standby facilities may be provided by the shut down of pumping circuits to the secondary areas.

5.20 The reliability of the plant and services should be specified at the early planning stage so that the design engineer can incorporate the necessary facilities to meet the requirement.

CHAPTER SIX: INSTALLING, TESTING AND COMMISSIONING AIR-CONDITIONING PLANT

General

6.1 Most cases of inability of the plant to maintain the required conditions when the computer is operational could have been avoided by comprehensive testing prior to the arrival of the computer. The commissioning and testing of the air-conditioning services for a computer installation is a matter of major importance to the project, and this requirement should be included in the contract documents for the installation.

Installation

6.2 The ducting and the plant should be erected if possible after completion of the building work. Where this is impracticable or where building alterations are made after the ducting has been erected, the ducting should be protected against entry of dust. Plant rooms should as far as possible be completed and cleaned before the plant is installed. Areas immediately outside all fresh-air intakes should be kept clean. Openings and orifices in plant and equipment should be kept sealed until they are connected to piping, ducting or conduit.

Cleaning associated with installation

6.3 Most building work produces debris and dust, which must be removed from the air-conditioned area before the air-conditioning is switched on, because dust is a particular menace to a computer, especially one using magnetic storage devices (see 3.8 to 3.14). The air-conditioned area must also be kept clean while any building work is in progress elsewhere in the building. Once the air-conditioning tests have been finished, that area should be recleaned and then maintained in accordance with the normal operating procedure.

6.4 The building methods and materials used should produce a minimum of dust and dirt, e.g by the use of prefabricated building sections and the elimination of wet trades. It is particularly important to eliminate dust from ceiling and floor plenums and the ducts of the air-conditioning system, so structural ducts, i.e ducts formed from brickwork or concrete, should be avoided since these materials produce dust throughout their life. Permanent shuttering, of galvanized steel, is a possible alternative if structural ducts are required.

6.5 The building specification should draw attention to the need for achieving cleanliness in the air-conditioned area and should include the following:-

(a) the building contractor shall clean the under-floor space before any false floor is installed;

(b) the air-conditioning sub-contractor shall be responsible for sweeping all ducts clean internally and ensuring that all open ends are temporarily sealed against dirt and dust as soon as ducts are installed. He shall further be responsible for ensuring that all parts of the air-conditioning duct system are clean and temporary seals removed before the fans are switched on;

(c) when the building work is complete (including decorating the air-conditioned area, fitting door locks, installing electrical sockets etc) the building contractor shall ensure that the whole air-conditioned area including the under-floor space and ceiling void is thoroughly cleaned, (i) by sweeping and (ii) by a specialist industrial cleaning sub-contractor. The sub-contractor shall clean the air-conditioned area with a vacuum cleaner on all surfaces including the under-floor area and ceiling void, and finally by using a damp or impregnated cloth on all these surfaces;

(d) the air-conditioning sub-contractor shall not run the main fans until all the work specified above has been completed;

(e) when this work has been completed access to the air-conditioned area shall be restricted to the minimum number of staff (impregnated mats shall be used at all entrances);

(f) if any building work is in progress in other parts of the building during the cleaning specified above, or after, the main building contractor must take all necessary precautions to prevent contamination of the clean area; and

(g) when the air-conditioning tests and adjustments have been completed and all test equipment removed, the air-conditioned area should again be thoroughly cleaned by a specialist sub-contractor: it should not be necessary to remove the false floor.

It is essential that sufficient time be allowed for this cleaning work. The timetable in Chapter 8 is suggested.

Programmes

6.6 In the project programme a period of three to eight weeks should be allowed between the nominal completion of the air-conditioning installation by the contractor and the arrival of the computer. The time allowed should be divided broadly into three periods; the first is for cleaning, commissioning and testing; the second is for the heating and ventilating contractor to correct "teething" troubles, re-commission and demonstrate particular tests (see Annex B); and the third is a margin for rectification, running-in the plant, final cleaning and giving due notice of readiness of the site for delivery. Experience has repeatedly shown that time for rectification, commissioning and testing is essential.

6.7 During the installation of the system, care should be taken in checking that all plant provided meets the design specification. Before commissioning, the entire installation should be examined for cleanliness: this should include any builders' work ducts and chambers and the areas immediately outside fresh-air intakes.

Responsibility for testing

6.8 A clear statement should be given in the specification of all tests required and of the final acceptance test with simulated heat load. The contractor should be responsible for commissioning and testing the entire system and the client's representative should witness the final acceptance tests. The responsibility for the provision of dummy heat loads to simulate the computer load and other heat loads on the building should be clearly defined in the building contract.

6.9 A summary of the recommended tests and procedures to be adopted is given in Annex B.

Mains supply

7.1 Small scale computer systems (micros, minis) often require only a single phase 240V 50Hz supply (up to 10kVA) and may operate satisfactorily from a normal office supply. Problems with the supply can normally be resolved by installing radio frequency interference (RFI) suppression filters or constant voltage transformers (CVT) - see Annex C, or by providing a dedicated supply cable.

7.2 Most medium to large scale computers require a three-phase five wire mains supply (TN-S System). The total power requirements for a computer and peripheral equipment will range from several kVA to several hundred kVA depending on the size of the installation. In addition, the power load of the air-conditioning plant may be three times that of the computer load. In assessing the requirements of a particular installation, allowance should be made for future extensions of the computer and ancillary equipment. For the largest installation the load may require a new feeder and switch gear or even a new sub-station.

7.3 For large installations it is recommended that a separate feeder be provided for the computer supply and preferably taken directly from the sub-station. Where this is impracticable or where the system is small the feeder should be taken from the main incoming "bus" bars for the building. The computer supply should be dedicated, all other supplies for the computer room such as air conditioning, ring mains, lighting etc, coming from a separate feed.

Power line protection

7.4 The quality of power supplies for equipment is largely dictated by the computer equipment suppliers' specifications. Checks must be made on the voltage and frequency levels and limitations to ascertain whether or not special precautions are likely to be necessary. Normally, current designs for most computer equipment from the major suppliers allow operation on electrical supplies of the same tolerance as that of the Electricity Board Mains (415/240V ± 6%, 50Hz ± 1%). The Electricity Board cannot however guarantee that the customer will receive the supply within these limits or that the supply received will be free from interference.

7.5 The devices listed in Annex C are designed to improve the quality of the mains supply and their use should be considered if mains quality is likely to be unacceptable to the equipment supplier. These may be accommodated in a power room which should also allow space for starters and control and distribution panels. Lifting beams are also desirable to facilitate machine overhauls. When the power room accommodation is being chosen, account should be taken of floor loading, noise, ease of access and the need for ample ventilation to dissipate heat. Double doors 1.8m wide should be provided. (It may be convenient to combine the power room with the air-conditioning room.

Power Distribution inside the computer room

7.6 For all but the very smallest systems it is good practice to feed computer equipment from a Power Distribution Unit (PDU) via suitably rated minature circuit breakers (MCBs) each item of hardware being hard-wired into junction boxes, normally located underfloor. Thermally operated MCBs are preferred as this type can usually be rated somewhat lower than the maximum surge rating and are designed not to trip out on short surges. The PDU includes a main contactor to allow easy and immediate electrical isolation in case of emergency, by manual push button(s) within the computer room; and automatic cutouts from systems such as fire detection where these are installed.

7.7 A mains supply monitor is recommended for medium/large scale systems to indicate whenever the voltage and frequency deviate from preselected limits. These monitors can normally be incorporated within a PDU generally located against the wall of the computer room or engineers' room.

7.8 A separate, insulated earth, of impedance not greater than 1 ohm, is normally taken to the PDU. It is recommended that the supply cable to the PDU be of the steel wire armoured type with the armour earthed.

7.9 Cable routes, including earth leads, to the PDU should be kept as short as possible to reduce the effective supply impedance and reduce voltage drops along the cable.

7.10 All cables, wiring, earthing etc should conform fully with The Institution of Electrical Engineers (IEE) "Regulations for Electrical Installations."

7.11 Where a platform floor is installed final connections to equipment are taken via the floor void, to a point underneath the specific item and terminated in a link box, to which the equipment supplier can make the final connection. Different manufacturers have different requirements for the final link box arrangement and this must be discussed with the electrical services designer. (See 11.12 and 11.13 for small systems.)

7.12 The ability to switch off the power supply easily and quickly is an important fire and safety precaution. An emergency push-button should be provided near the computer control console, to cut off all power supplied to the computer. In addition, emergency switches should be placed within the computer hall near the main doors to cut off the power supply to the equipment, the air-conditioning and other power points, except lights. These switches should be clearly indicated and should be shrouded against accidental operation.

7.13 Socket outlets, for the connection of test equipment or tools, are sometimes mounted within computer units; in addition wall and floor points are necessary. The risk of fire caused by soldering irons and test apparatus in the maintenance room and computer room will be reduced if a separate master switch is also provided for this circuit in or near the main entrance and if individual outlets are fitted with pilot lights or neon indicators.

7.14 Separate distribution is required for background heaters (see paragraph 3.17); these should be permanently wired to operate under thermostat and humidistat control when the air-conditioning plant equipment is switched off. This supply and that for lighting and points for cleaners' use must be left on after normal working hours.

7.15 Ancillary oil-filled electrical apparatus, such as transformers and switch gear, should be housed remotely from the computer equipment, in a separate room with the usual fire separation and provision for containing the oil in the event of fire.

Standby power supplies

7.16 If loss of computing because of periods of power loss cannot be tolerated, a standby supply will be necessary. The primary element of standby equipment is the electrical generating plant for use when normal mains supplies are unavailable. The size and type of plant can be resolved only by assessing the specific requirements of each particular project.

7.17 Two types of plant are most readily available; diesel engine driven alternators and gas turbine driven alternators. It is a pre-requisite that the standby plant be immediately available whenever the normal supply fails. This infers that automatic start be built into the control system, which should allow plant to be brought "on-line" and taking load within 30 seconds of supply failure.

7.18 The output of an alternator must be suitable to provide satisfactory operation of computer equipment. For most purposes this infers the same conditions as the normal mains supply ie., ±6% voltage; ±1% frequency tolerances. This involves the provision of automatic voltage regulators and electronic governors to control engine speed and hence, electrical frequency. Good control is essential to ensure rapid response to step load changes to maintain stability.

7.19 At large installations or where it can be predicted that large proportions of the total load will be switched suddenly it is preferable to install two generators; one to supply the computer equipment and another to supply the essential plant and services. This will reduce the incidence of sudden load changes on the computer generator and assist with good frequency control.

7.20 Further enhancement of security of operations is obtained by the installation of uninterruptible power supply (UPS) equipment. This equipment allows continuity of output in the time between mains failure and standby plant operation; the amount of time during which output can be sustained is dependent upon battery capacity. It is very expensive and may be justified only at the most operationally critical installations.

CHAPTER EIGHT - TIMETABLE OF OPERATIONS

General

8.1. Computer manufacturers provide an installation engineering service which advises on planning the accommodation and supervises the installation of the computer. To ensure that accommodation matters are considered in good time, the timetable in the following paragraphs is suggested. (Data preparation equipment is excluded since it may be delivered before the computer).

Investigation or Feasibility Study Stage

8.2 The architect should be notified of the likely requirements as soon as a proposal to install a computer is agreed in principle. At this stage the make of computer need not be settled but it should be possible to estimate broadly the accommodation needed and to consider possible sites. A preliminary estimate should be made of the date by which the accommodation will be needed so that it can be taken into account in the project timetable. The provision of suitable accommodation is invariably longer than the procurement time for the computer system.

Tendering stage

8.3 The requirements can now be defined more precisely and the architect should be kept informed. When a site has been selected (whether in present accommodation or elsewhere) responsibility must be established for co-ordinating the various works services concerned with building construction or alterations, floor strengthening, false flooring, suspended ceiling, heating, lighting, water supply, acoustic treatment, fire prevention and technical auxiliaries such as sub-stations, switch gear, cabling, air-conditioning plant, motor alternators and standby generators.

8.4 As the planning and execution of the building work may take longer than the delivery period the computer manufacturer offers, as much as possible of the planning work for the building and engineering services should be done before the computer is ordered. A date by which the accommodation will be ready, cleaned and with a fully tested plant, should be agreed with the builder and taken into account in deciding the date for delivery of the computer.

System ordered

8.5 As soon as the computer has been ordered, there should be a full exchange of information among buyer, architect, builder and the manufacturer's installation engineers, and agreement reached on the layout of equipment, on any outstanding details of building construction, including any special provision of access for delivery, and technical auxiliaries, e.g. electrical power and air-conditioning plant. Delivery dates for these should be obtained.

8.6 The following part of the schedule assumes a fairly large installation but the intermediate points should not be taken as hard and fast. For a small installation the eight week period (see 8.9) could be reduced to three and the rest pro rata.

Twelve months before delivery of system to the site

8.7 Telephone requirements should be agreed and the order placed.

Four months before delivery

8.8 Any modifications that have been made to the layout plans of the equipment should be agreed with the equipment manufacturer and thereafter no further modifications made. The flooring and electrical sub-contractor should be told of floor cuts and cabling details.

The remaining period before delivery

8.9 Eight weeks before delivery the air-conditioning system should have been installed. The building trades should have completed all their work. The high grade cleaning as detailed in paragraph 6.5 should start.

8.10 Seven weeks before delivery the air-conditioning contractors' commissioning and test running should commence.

8.11 Six weeks before delivery the balancing and checking of air volumes should start.

8.12 Five weeks before delivery further test running by the contractor including load tests followed by a demonstration of the plant to the client or his representative as is detailed in Chapter 6 and Annex B. Any major modifications should be undertaken a this stage and retesting may be necessary.

8.13 Four weeks before delivery the final surface cleaning should be started, the computer suppliers notified that the site is ready for the final inspection and cabling check; and that it is otherwise in order to proceed with delivery arrangements.

8.14 The remaining period should, ideally, be used to run the plant normally so that it may prove itself. However, it is usually necessary to make some final adjustments and minor modifications, before undertaking the final cleaning. Thus this period should not be reduced even if the earlier parts of the project are behind schedule.

Delivery

8.15 The architect should co-operate with the equipment manufacturer to ensure access for large delivery vehicles and crates, removal of windows and doors as necessary to allow entry of the equipment, and any temporary reinforcement of floors that may be needed in passages, rooms and stairways through which heavy loads have to pass. Temporary storage space that may be needed by the manufacturer for packing cases and boxes and temporary accommodation for his staff should be provided if necessary. The Users' cleaners should be in attendance.

Installation

8.16 Connection of the computer equipment to the power supply should be made the responsibility of the equipment supplier and this should be agreed at the time of contract. After installation there follows a period of testing and commissioning by the computer manufacturer which may vary from a day to several weeks depending upon the size of machine. During this period it may be necessary for the air-conditioning contractor to adjust the air balance and controls to eliminate hot spots.

CHAPTER NINE - FIRE RISKS

General

9.1 This subject is fully discussed in BS6266: 1982 "Fire Protection for Electronic Data Processing Installations".

9.2 The fire precautions recommended in these notes relate to modern equipment which has a low intrinsic fire risk; the main concern is to protect this equipment against external hazards. In all cases, the local fire authority or other qualified adviser should be consulted. This is particularly necessary where:-

(a) the installation will utilise combustible material in a new way;

(b) equipment is to be housed in a building not of modern fire resistant construction;

(c) the operational risks are higher than normal, eg where the installation or mechanical ventilation plant may be left running unattended (paragraph 10.10);

(d) the ventilation system could spread smoke or hot gases from other areas to the computer room or stores ;

(e) the equipment includes cabinets employing closed circuit air ventilation.

Fire protection

9.3 Accommodation requirements for computer-based equipment must be considered together with the need to provide protection against fire risks from both inside and outside the building. Within the suite, the risk can be reduced significantly by segregating fire hazards from vulnerable records (see 2.12) by choice of materials, by choice of equipment and by the suitable design of ventilation equipment (Chapter 5). Paragraphs 9.7 to 9.11 deal with structural precautions.

9.4 Protection of important records against heat, smoke, electrical disturbances, water, malicious damage etc, is provided if they are duplicated and kept in a store, sited so that they would not be involved in the same incident. Where a data record is unique or cannot be removed to a safe place, fire safes may be considered but these will not always safeguard magnetic media in the event of a fire.

Fire Protection equipment

9.5 If adequate precautions cannot be taken through architectural, engineering and operational measures, to reduce the fire risk to a minimum, the use of automatic fire protection measures should be considered. At unattended installations detectors fitted should be arranged to switch off all power supplies to the air-conditioning system and computer equipment other than those serving the lighting and emergency smoke extraction system.

9.6 It is important that the final commissioning of the automatic fire protection equipment is undertaken after satisfactory commissioning of the air-conditioning or mechanical ventilation system.

Structural fire precautions

9.7 The whole structure of the building should be adequately fire resistant. It may be necessary to design above the Building Regulations minima for the computer suite floor and its supports to ensure minimum disturbance in case of serious underfloor fires involving high calorific content combustibles. Perimeter walls to the suite should also have a fire resistance related to the occupancy fire load. Doors should be self closing.

9.8 Where there is any doubt about the adequacy of fire resistance, rooms below should be restricted to use with a low fire risk, eg offices, but not for storage of combustible materials or for hazardous industrial processes.

9.9 Accommodation on floors above computer suites should be restricted similarly to minimise the risk of having to use water in extinguishing a fire. Services should not pass through a computer suite. The floor above should be water proofed and draining may be justified.

9.10 The minimum space separation required by the Building Regulations may not be sufficient to protect sensitive equipment especially where neighbouring sites were developed before these regulations came into force. Windows exposed to external fire risks may be protected by fixed fire-resistant glazing, but in severe cases bricking-up may be desirable.

9.11 Within the computer suite, desirable structural precautions include the following:

(a) Partitions, doors, hatches and glazing should generally have a fire resistance of at least half an hour. A higher degree of fire resistance may be required to contain a fire in a stationery store or to protect records from heat (glazing will not give sufficient protection from heat radiation). Here partitions should extend from true floor to true ceiling. Similarly, where a partition adjoins a compartment or external wall it should make a fire tight seal to prevent fire spreading to any cavity formed by wall linings.

(b) Acoustic treatment, suspended ceilings and any decorative linings should be of non-combustible materials and should not as far as practicable give rise to the production of dust, corrosive or toxic fumes, when heated.

CHAPTER TEN - OPERATIONAL SAFETY AND FIRE PRECAUTIONS

General Considerations

10.1 Management should ensure that clear instructions are provided to staff to ensure that they can perform all their duties without risk to their health and safety. Special consideration should be given to what this may involve if staff are required to work alone.

Smoking

10.2 Smoking should be prohibited in computer accommodation and "NO SMOKING" signs should be exhibited prominently. Ash trays or sand bins should be made available immediately outside prohibited zones. Smoking should be strictly controlled in office areas accommodating computer equipment through the provision of separate smoking areas where practicable. Good housekeeping is essential and the avoidance of build-up of combustible materials will assist in minimising the fire risk.

Action in case of fire during working hours

10.3 Where cabinets are kept locked and only engineers are allowed to open them, keys should be held in computer rooms, preferably in a glass case. When one key does not open all the cabinets each key should be clearly labelled. If access is to be restricted to a nominated computer engineer and time could be lost in locating him, it may be necessary to install a loud speaker or similar device. Clear instructions should be displayed in computer areas on the action to be taken if fire occurs. These should include the following:-

(a) turn off master switches for machines, ventilation and ancillary plant;

(b) notify the telephone operator who will call the fire brigade;

(c) evacuation procedure;

(d) notify key personnel; and

(e) attempt to extinguish the fire with equipment available (Halon 1211(BCF)) on electrical apparatus, fire blankets on waste paper baskets, etc without taking personal risks.

Action to be taken before staff leave the premises after working hours

10.4 Clear instructions should be displayed on the action to be taken by staff before leaving the premises, eg that they:-

CHECK

(1) all doors and hatches between rooms are closed;

(2) all waste paper has been removed;

(3) all ancillary and miscellaneous equipment (eg soldering irons) has been unplugged from sockets;

(4) all master switches have been turned OFF;

(5) any gaseous automatic fire extinguishing system is on automatic control;

(6) all records have been returned to store rooms or safes; and

(7) any area where workmen have been carrying out building, engineering or maintenance operations is inspected.

Final inspection

10.5 A final inspection by a member of the maintenance or operating staff after other staff have left the premises should be arranged and it may be possible to ensure that computer accommodation is patrolled. When a building housing computer equipment is watched or patrolled continuously outside normal working hours, the arrangements should specifically provide for periodic visits to the computer area.

Automatic fire extinguishing systems

10.6 No person should be permitted to enter a room protected by gaseous means until the automatic feature of the fire extinguishing installation is locked out.

Fire extinguishers

10.7 The items mentioned below would provide a reasonable minimum within the computer room and/or within reach of the engineers' room and the ancillary equipment:-

(a) computer areas up to 200 sq m:
2 x 1.5Kg BCF extinguishers
1 x 1.2m square fire blankets;

(b) computer areas greater than 200 sq m:
As in (a) plus 1 x 1.5Kg BCF extinguisher for each additional 200 sq m;

(c) Communications Areas and Engineers' Room
1 x 1.5Kg BCF extinguisher + Fire Blanket.

10.8 Because of extensive damage to equipment which could be caused by use of water to extinguish fire in or near electronic equipment, the initial attack on any such fire should be made with the special equipment mentioned above. Computers and ancillary equipment normally contain opening doors or ventilation grilles through which BCF could be injected quickly. Staff should know how to use the equipment provided.

Liaison with local fire brigade

10.9 The local authority fire brigade should be made aware of the existence of the computer equipment and of the need to avoid damage by water seeping through floors in the event of a fire elsewhere in the building and the need to avoid breaking windows.

Unattended running

10.10 Computing capacity is valuable and hours of working tend to increase from a single shift to almost continual working. The tendency is to reserve jobs taking most time for the night shift when fewer operators may be required. Such jobs may be fed to the computer by the operating personnel before departure, leaving the machine running unattended except for a supervisor or watchman. Such personnel should be carefully briefed on their duties (and in particular those in paragraphs 10.3-10.5). Fire detection equipment (and in some circumstances automatic extinguishing equipment) is recommended where it is intended to energise unattended equipment (including packaged type air handling units) in the computer area as the normal course of events. The design and installation of fire protection systems should be carried out only by those skilled in this work.

General

11.1 In future much more electronic equipment will be installed in office accommodation. This chapter provides some broad guidance on factors that need to be considered when installing small systems based on visual displays. The recommendations are directed to the accommodation of visual display systems when used in accommodation other than purpose-built computer accommodation.

Types of visual display systems

11.2 Many visual display systems comprise a visual display unit (VDU) and keyboard, usually detachable, and sometimes a separate controller or line concentrator. The controller/concentrator (each can usually serve 8 or more displays) need not be directly accessible to the operator and with a larger, clustered, system, could stand in a corner of the room or in a nearby separate one. As well as the visual display system the operator's desk could support a hardcopy printer, diskette unit, telephone, desk light, document stand, disk and document storage, and storage for personal belongings. Such systems can be used for a wide variety of tasks including data preparation, word processing and interactive automatic data processing; and accommodation features should be considered in respect of the operating characteristics of each type of application:-

(a) data preparation systems operators type data into the system, copying from manuscript, occasionally glancing at the display to validate the input, but no prolonged period of time will be spent reading from it. The emphasis in this task is on fast keying. The environment required is similar to that of a typing pool in respect of lighting and noise levels (350lux and NR 40 to 45) but relative humidity, static discharge and heat dissipation should be taken more into account.

(b) Word Processor operators perform a similar task. They copy text from manuscript, typescript or from audio tapes; but their use of the screens is different. Instead of entering data into pre-formatted fields, WP operators generally use the screen for editing and laying out text, in addition to necessary checking. When designing the accommodation, account will have to be taken of lighting and reflections; of furniture layout to avoid glare and sight of other displays; of temperature resulting from additional equipment; relative humidity; static discharge; noise; space; and work station design.

(c) Operators of interactive systems make use of the information displayed on the screen and generally spend more time reading from it than with data entry or word processing systems. There is less typing to be done and frequently little or no need to enter data directly from documents. Often the operator is a casual user and is not, as with typing and data entry systems, seated for long periods before a terminal. Various applications include telephone enquiry, information retrieval, record updating, program development and text composition.

Facilities for Visual Display Systems

11.3 Particular attention needs to be paid to illumination of reading surfaces and to the minimisation of screen reflections, irritating glare and flicker. Individual desk lights and partitioning screens may be needed for some applications. Work stations should be individually designed to best suit the particular task. [Note: Steps to minimise specular reflections on VDU screens should be taken wherever possible. It is recommended therefore that cathode ray tubes (CRT's) are fitted with panels having an etched surface and optical antireflection coating. Where screens are not fitted with such panels reflections can be reduced by using antiglare filters. The most effective types currently available are those that employ either a mesh, a neutral density filter or a polarising filter].

11.4 Data communication lines will need to be brought into the office. For simple systems these may be associated with the normal telephone. For others, data modulators/demodulators (Modems) will be required which, for some systems, could be situated in a corner of the room; but where, say, a number of offices are to be served with a dozen or so lines and modems, a special room could be allocated for the purpose. Purpose designed racks should be used where more than a couple of modems are to be installed.

Temperature, Humidity and Dust control

11.5 In general, visual display systems will work satisfactorily within the temperature range that typically prevails throughout the year in occupied office accommodation. However the nature of the tasks performed by the operators and the technologies used within some equipment will sometimes dictate stricter control of the environmental parameters.

11.6 If the equipment is sensitive to dust or relatively large changes in temperature or humidity, a separate partitioned area with the necessary environmental control should be provided.

11.7 In most cases, natural or mechanical ventilation will provide acceptable temperatures for operators but where the heat dissipated by the equipment is likely to raise the ambient temperature by 2°C or more, consideration may need to be given to measures to limit the temperature rise. The most comfortable working temperature range for personnel is approximately 20°C to 26°C and 40% to 70%RH.

11.8 The cooling effect of air movement is well known and, if excessive, people undertaking sedentary tasks will complain of draughts. Approximate acceptable air velocities over the skin within the comfortable working temperature range of 20°C to 26°C are 0.1m/sec and 0.5m/sec respectively.

11.9 In applications where the screen is viewed for long periods it is desirable that relative humidity should not fall below 40%.

11.10 The electrical resistance between the top of the floor surface and the electrical earth for the building should be kept below 2×10^{10} ohms to minimise the risk of electrostatic discharge. The effect of humidity will need to be taken into account.

11.11 Filtering the room air will only normally be required when high density magnetic media is used.

Power Supply

11.12 Visual display systems should operate from the normal mains supply, and any problems with power supplies can usually be overcome by providing a dedicated subcircuit or some form of line conditioning equipment such as a constant voltage transformer or a filter (see Annex C).

11.13 Certain equipment may require a greater supply than 13 amps, if only to cater for heavy starting currents (eg that taken by free-standing disk units, typically, 20 to 30 amps). The power distribution in the visual display system area should allow for flexibility and safety of cable layouts to equipment.

Illumination

11.14 It is recommended that for most applications, working areas for visual display systems should be illuminated with an artificial lighting level of 350 lux, with shielding against both direct and reflected glare.

11.15 For applications where much of the time is spent reading from documents, the lighting level should be increased towards 500 lux. For some applications where the operator reads only from the screen a lighting level below 350 lux may be preferred.

11.16 For mixed applications "task" lights may be required.

11.17 Wherever possible visual display screens should be at right angles to windows and luminaires.

Noise

11.18 Background noise levels and office characteristics such as sound reflection and absorption will influence the way in which noise generated by equipment affects the occupants. Noise can be a source of irritation and fatigue and consideration should be given to reducing the noise level as much as possible. Appropriately placed furniture screens can help to reduce noise and printers can be fitted with acoustic hoods. If a large amount of printing has to be done it might be possible to have a shared facility remote from work stations which could more easily be sound insulated.

Health and Safety

11.19 Since much more electronic equipment will be mounted on and around office desks, all cables which could get entangled with an operator's feet should be secured and covered; suitable channelling for all cables which cross walkways should be provided. It is also important that the furniture selected be stable when carrying electronic equipment. Careful attention to these points will reduce the risk of electric shock or other physical injury. It should however be realised that operating requirements change and new work station configurations may frequently be necessary; so flexibility of the wiring installation should always be an important design factor.

11.20 Relative humidity and static charge need special consideration where operators are required to spend long periods operating visual displays. Low humidity can contribute to eye irritation which, for some operators, may increase their awareness of possible eye discomfort brought on by prolonged viewing. Static discharge can be uncomfortable for the operator and can cause equipment malfunction.

11.21 Each group of video display system work stations occupying an office or part of a larger office should have user accessible means of isolating the power supply, conveniently situated, preferably close to a nearby exit. Its purpose is to serve as an emergency switch and as a convenient means of isolating all equipment at the end of the day, to reduce fire risk and conserve energy.

11.22 Where a VDU is used at more than one location within an installation, care should be exercised to ensure that trolleys used for transportation are stable when loaded.

INFORMATION TECHNOLOGY
IN THE CIVIL SERVICE

ACCOMMODATION FOR COMPUTER AND OFFICE SYSTEMS

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INFORMATION TECHNOLOGY IN THE CIVIL SERVICE

Information technology involving the convergence of computer, telecommunications and office machines, is beginning to have a significant impact upon society today. The Civil Service is the UK's largest user of information technology, operating a wide range of computers, telecommunications networks for voice, data, text and image processing, advanced input and output devices, word processors and new office systems. It is responding positively to the challenge which technology now offers to increase the economy, efficiency and effectiveness of Government operations.

Computing power is now potentially available to the ordinary office on the same wide scale as telephones, photocopiers and typewriters. But the "office" has diverse and personal systems of operation which are not easily structured for the application of information technology. Both suppliers and the users of information technology systems need to increase their understanding of the environment in which they will be operated; the one to develop more suitable products, the other to define more clearly their requirements for these products.

The Central Computer and Telecommunications Agency (CCTA) of HM Treasury is leading a programme of work to explore these issues as they affect the Civil Service. This programme encompasses strategic studies, trials initiated for the purpose of exploration, and analyses of the experience from a number of systems already in operation. The CCTA works closely in this with Government departments, including the Management and Personnel Office (MPO) which is responsible for the central policies on personnel management and efficiency in the Civil Service.

This work, while addressed particularly to the administration of the Civil Service, has relevance for other large organisations and for suppliers. The Government has therefore decided that the results should be made publicly available through this series of occasional papers.

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NOTES FOR CENTRAL GOVERNMENT USERS

'Accommodation for Computer and Office Systems' has been written as a general guide for prospective users of computers and office systems. In addition to the advice given, assistance and technical advice is available to departments from the Property Services Agency (DOE) and the Central Computer and Telecommunications Agency (HM Treasury). Advice and assistance on security matters is obtainable through Departmental Security Officers who should be consulted as early as possible during the planning and design stages of a project.

The provision of accommodation for computer equipment and office systems will lie on the critical path of most projects and it will be necessary to prepare an accommodation design brief at a very early stage. The Installation Services Section of CCTA will provide advice on environmental requirements and assist in preparation of the brief which the PSA is responsible for interpreting and implementing. The PSA will assume the duties outlined in the notes for the architect and engineer and will co-ordinate the various work services including balancing the air-conditioning and checking that the required design conditions can be maintained. The user must provide firm assurances on accommodation funding and availability to CCTA and a date agreed with the PSA by which the accommodation will be ready before any contract can be placed for computer equipment. PSA Supplies should be consulted about the provision of floor-covering, furniture, storage equipment and shelving.

The provisions of this Guide, although written primarily in the context of the computing environment, apply in many instances to the smaller, office-based systems. In particular, additional guidance on the use and installation of systems based on Visual Display Units (VDU's) is contained in the 'Joint CCTA/CCSU Guidance on the Human Factors Associated with the use of Cathode Ray Visual Display Units' and also the 'Report of the CCTA/PSA Working party Examining the Requirements for Accommodating Visual Display Systems in Government Offices'. These are available from the Central Computer and Telecommunications Agency (CCTA), PIB, Riverwalk House, 157-161 Millbank, London, SW1P 4RT.

INTRODUCTION

These notes are intended for the guidance of prospective users who are not familiar with the problems likely to be encountered in planning accommodation for large and small computer systems which may be installed in purpose built or office type accommodation. Such installations vary greatly in size, composition and complexity: these notes are based upon the requirements of computers with paper handling peripherals and magnetic storage devices eg printers, tapes and disks. Simplified treatment may be appropriate for smaller installations; Chapter 11 provides some broad guidance on factors that need consideration when installing computer-based systems with visual displays, in office accommodation.

Accommodation for telephone exchanges, programmers, reception and despatch, stores, welfare etc is not covered in detail. For authorities within the Public Sector the Property Services Agency (DOE) and the Technical Services Organisation of the CCTA (HM Treasury) can give technical advice on accommodation and environmental requirements. The need to observe the provisions of the Building Regulations and other statutory requirements must be borne in mind.

PSA Supplies is the Government's Purchasing Agency for a wide range of commodities, including furniture and storage equipment suitable for computer installations. These items are available to all public sector bodies at competitive prices. (Contact: Client Liaison, Room 901, Southbridge House, Southwark Bridge Road, London, SE1 9HQ).